ZOOLOGIA 35: e13047
ISSN 1984-4689 (online)
zoologia.pensoft.net

RESEARCH ARTICLE

A new species of *Aulacigaster* from Zurquí de Moravia, a Costa Rican cloud forest (Diptera: Aulacigastridae)

Alessandra Rung[1]

[1]*Plant Pest Diagnostics Branch, California Department of Food and Agriculture, 3294 Meadowview Road, Sacramento, CA 95832-1448, USA.*
Corresponding author: Alessandra Rung (arung@cdfa.ca.gov)

http://zoobank.org/81FC57DC-9305-4899-8959-F4B818D29DD1

ABSTRACT. A new species of *Aulacigaster* Macquart, 1835 *A. zurqui* **sp. nov.**, is described from Costa Rica. The new species, which is classified in the *plesiomorphica* species group following a cladistics analysis, can be separated from all congeners by having a triangular 1st flagellomere and stout body that is uniformly dark-brown to black. An expanded diagnosis of the *plesiomorphica* group and a modified key to the Neotropical *Aulacigaster* are provided to accommodate the new species.

KEY WORDS. Acalyptrate, *Aulacigaster zurqui*, Central America, Neotropical Region, taxonomy.

INTRODUCTION

Two species of the dipteran family Aulacigastridae were collected as part of the ZADBI project (Borkent and Brown 2015), a 3-year grant funded by the National Science Foundation (NSF) to estimate fly diversity within a Costa Rican cloud forest, Zurquí de Moravia (hereafter referred to only as Zurquí). One is *Aulacigaster melanoleuca* (Hennig, 1956), originally described from Costa Rica and widespread in that country. The other is described here as new.

Aulacigastridae are a small family of acalyptrate flies with two extant genera, *Aulacigaster* Macquart, 1835, distributed worldwide, and *Curiosimusca* Rung et al. (Rung et al. 2005) from the Oriental Region. *Aulacigaster*, now numbering 56 species (Rung and Mathis 2011; this contribution), have been observed associated with slime fluxes of deciduous trees (Robinson 1953, Cole and Streams 1970, Davis and Zack 1978, Ferrar 1987, Mathis and Freidberg 1994, Hilger and Kassebeer 2000, Papp 2008, Rung and Mathis 2011) or with the phytotelmata of bromeliads (Rung and Mathis 2011). In the Neotropical Region, 38 species are known to occur, divided among six species groups (Rung and Mathis 2011; this contribution): the *leucopeza* group, also with species in the Nearctic Region and Old World, and the *bromeliae*, *ecuadoriensis*, *femorata*, *grimaldii*, and *plesimorphica* groups, which are exclusively Neotropical.

In this paper, I describe a new species of *Aulacigaster* from Zurquí. Since the genus has already been revised (Rung and Mathis 2011) and no additional species have been described since, a comprehensive revision is not necessary. The new species can be separated from all congeners by the triangular shape of the 1st flagellomere and by having a stout body that is uniformly dark-brown to black. In addition to the species' description, I present evidence that it belongs to the *plesimorphica* group, provide an expanded diagnosis of the group, and indicate where the new species fits in the "Key to the Neotropical Species Groups and Species of *Aulacigaster* Macquart" (Rung and Mathis 2011: 6–9).

MATERIAL AND METHODS

The descriptive terminology is from McAlpine (1981), except that the nomenclature for the structures of the male terminalia follows Cumming et al. (1995).

The following ratios are used in the new species' description and appended key: 1) scutal ratio: the greatest length of scutum divided by the greatest width of scutum; 2) head ratio: the greatest length of head divided by the greatest height of head.

Specimens are small and study and illustration of the male terminalia required the use of a compound microscope. Photographs were taken with a Nikon Coolpix Ds-Fi1 digital camera through a Nikon SMZ1500 dissecting scope and were assembled using Combine Z. The photographs were enhanced, formatted, and arranged in Adobe Photoshop 7.

Drawings of the male terminalia were traced over pictures assembled using Combine Z, taken using a Nikon Coolpix Ds-Fi1 digital camera through a Nikon Eclipse 600 compound microscope.

The consensus cladogram was drawn in Adobe Illustrator CS6.

A phylogenetic analysis was performed to ascertain where the new species fits the phylogeny provided by Rung and Mathis (2011). To this end, the character matrix in Rung and Mathis (2011: appendix) was expanded to include the new species, with the following character states added to the last row "11111111113311-121121311." Analyses were done using PAUP 4.0 (Swofford 2002). The matrix was analyzed with a branch-and-bound search, with all characters unordered and equally weighed, followed by three iterations of successive weighting (Farris 1969). For more information about the choice of ingroup and outgroup taxa, consult Rung and Mathis (2011).

RESULTS

Phylogenetic position of *A. zurqui* sp. nov.

Adding *A. zurqui* sp. nov., to the matrix of Rung and Mathis (2011: appendix) (see Materials and Methods), and performing an exhaustive search, resulted in 17 optimal trees with 41 steps, a consistency-index of 0.78, and a retention index of 0.91. The competing topologies differ in the the relationships among the species of the *leucopeza* group. In all reconstructions the relationships among the *bromeliae* and the *plesiomorphica* (now including *A. zurqui* sp. nov.) groups and the remaining species of Neotropical *Aulacigaster* (a clade composed of the *grimadii*, the *ecuadoriensis*, the *minuta* and the *femorata* groups) resulted in a trichotomy (Fig. 1).

The *strict consensus* cladogram of the 17 trees obtained in this analysis (Fig. 1) does not differ from one obtained by Rung and Mathis (2011: 118, fig. 202), except for the addition of the new species. In the present work, the new species clustered with the *plesiomorphica* group, sharing with it one homoplasious, yet unambiguous, synapomorphy, the presence of a group of long, strong setae on one of the posterior processes of the gonopod (character 22, state 3 in Rung and Mathis 2011: 116; Fig. 8). This process is also present in two species of the *ecuadoriensis* group present in the analysis, *A. ecuadoriensis* (Hennig, 1969) and *A.*

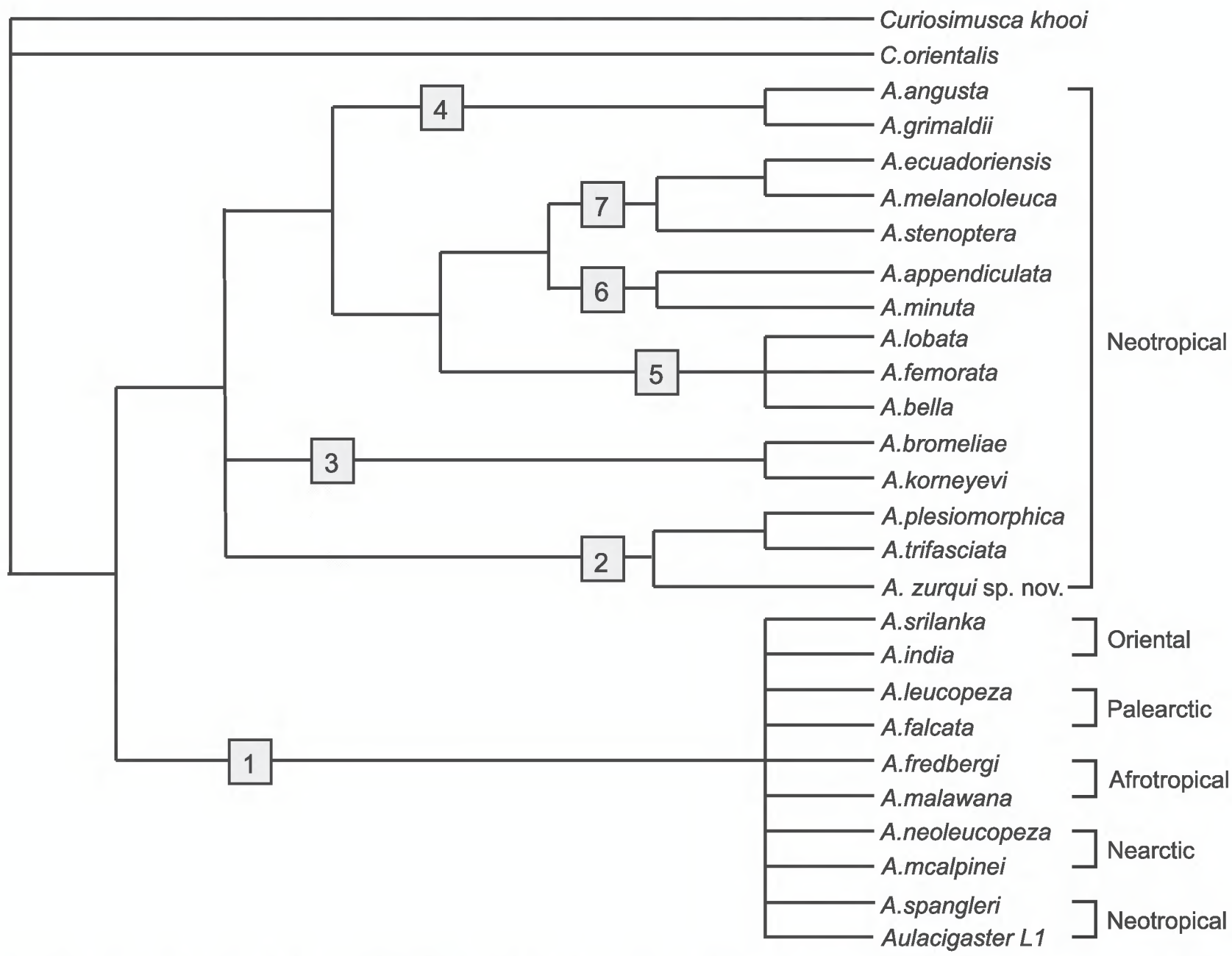


Figure 1. *Strict consensus* cladogram obtained from 17 optimum trees, summarizing a cladistics analysis of *Aulacigaster*. The optimum trees were obtained with a branch-and-bound search, characters unordered and equally weighted, and have 41 steps, consistency-index (CI) 0.78 and retention index (RI) 0.91. The number on the nodes indicate the species-groups as follows: 1. The *leucopeza* group; 2. The *plesiomorphica* group; 3. The *bromeliae* group; 4. The *grimaldii* group; 5. The *femorata* group; 6. The *minuta* group; 7. The *ecuadoriensis* group.

melanoleuca (Hennig, 1956). *Aulacigaster zurqui* sp. nov., also shares with those two species, the triangular shape of the first flagellomere (character11, state 3 in Rung and Mathis 2011:116; Figs 2–5). However, it lacks a uniquely derived character of that group, the pleural region white on the lower half. It also lacks the elongated body, a synapomorphy that unites the *ecuadoriensis* and the *minuta* groups.

Given the results of the cladistics analysis, I have decided to place the new species in the *plesiomorphica* group, despite some taxonomic ambiguity. *Aulacigaster zurqui* sp. nov., lacks some of the striking characters that are used to diagnose the *plesiomorphica* group, such as the lunate silver stripe on the frons, and the characteristic shape of the face, which often bears a facial band. It is possible that, in the future, as new taxa are collected and new character systems are explored, a better placement for *A. zurqui* sp. nov. will be found.

Modified key to species

The new species keys out to couplet 6 in the "Key to the Neotropical Species Groups and Species of *Aulacigaster* Macquart" (Rung and Mathis 2011: 6–9). In couplet 6, the *plesiomorphica* group is separated. Couplet 6 is herein modified as follows, to accommodate for this new species (changes to previous key in boldface):

6 Frons mostly brown, at most with anterior margin pale, yellowish (Rung and Mathis 2011: figs 207, 209); anepisternum mostly polished 7

6' Frons with anterior 1/2–1/3 often yellowish in ground color (yellowish portion of frons invested with dense microtomentum, silver under certain angles) (Rung and Mathis 2011: fig. 203). If frons completely dark, then 1st flagellomere is triangular (Figs 2–4); anepisternum mostly dull microtomentose (the *plesiomorphica* group) 16a

16a Frons completely black; 1st flagellomere triangular (Figs 1–5) ..... *A. zurqui* sp. nov.

17b Frons with anterior 1/2–1/3 yellowish in ground color; 1st flagellomere rounded 18

Diagnosis of the *plesiomorphica* group, adapted from Rung and Mathis (2011: 64) (changes to original diagnosis in bold).

The *plesiomorphica* group

Figs 2–9

Rung and Mathis (2011: 64: figs 132–160, 213–214).

Diagnosis. The *plesiomorphica* group is distinguished from other species groups by the following combination of characters: Stout, medium-sized flies, body length 2.4–3.5 mm. Coloration and vestiture: Frons often with anterior1/3–1/2 yellowish in ground color, rarely completely black; anterior portion of frons densely microtomentose, often with microtomentum forming a wide, lunate, silvery stripe; facial band often present. Anepisternum mostly dull microtomentose. Abdomen in a few cases with a large, white to yellowish region on syntergite 1+2. Morphology: Head: Head higher than long (head ratio less than 0.9); 1st flagellomere often rounded, rarely triangular; face strongly convex on ventral 2/3, easily visible in lateral view; ocellar seta minute; fronto-orbital setae with posterior seta slightly internal to and almost transversely aligned with anterior seta. Thorax: Subcosta partially fused with vein R1 apically but terminated at costa. Male abdomen and terminalia: Surstylus a short, posteroventral lobe in lateral view; cerci often partially fused; subepandrial sclerite typically forming a single, platelike structure; gonopods often with 2 posterior processes; one bearing 4–5 strong, stout setae.

Distribution. Neotropical: Belize, Brazil, Costa Rica, Ecuador, Guyana, Panama, Peru, Venezuela.

Biology. There is sparse biological information on species of this group. Exemplars that were hand collected in the rainforest were captured on tree trunks and other aerial portions of large *Ceiba* trees with no visible, wound-exuding sapfluxes (Rung and Mathis 2011).

Discussion. Species of the *plesiomorphica* group are distinguished by the presence/absence of a facial band, the shape of the face, and coloration of the legs. In some cases, species can only be identified with certainty by referring to the shape of the surstylus and other structural characters of the male, such as the shape of sternite 5, presence/absence of setae on the hind trochanter and hind tibia.

With the addition of the species described herein, the *plesiomorphica* group includes 11 species. The group is exclusively Neotropical.

Aulacigaster zurqui sp. nov.

http://zoobank.org/52A173E0-D52E-4898-A14B-672805277A01

Figs 2–10

Type material. The holotype is mounted on a pin together with three labels as in Fig. 10. The holotype is double mounted (minuten in a block of plastic), is in fair condition (missing both wings, left arista, left foreleg, there is a hole in the scutellum and the abdomen is dissected). It is deposited in the MNCR (Museo Nacional in Costa Rica) together with the female paratype. The female paratype, also collected by the project ZABDI, has the following label information: Costa Rica. Prov. Cartago. Paraíso. P.N.Tapantí, 1600 m, 2–9 Dec 2012, Malayse, Zabdi-331, 09°43'21"N, 83°46'30'W, #105651.

Type locality. COSTA RICA. Prov. San José. Moravia. Zurquí de Moravia (10°02'58"N, 84°00'57"W).

Diagnosis. This species can be separated from all congeners by having a triangular 1st flagellomere and body stout, uniformly dark-brown to black.

Description. Coloration and vestiture: Vertex mostly polished, with a densely microtomentose stripe posterior to ocellar

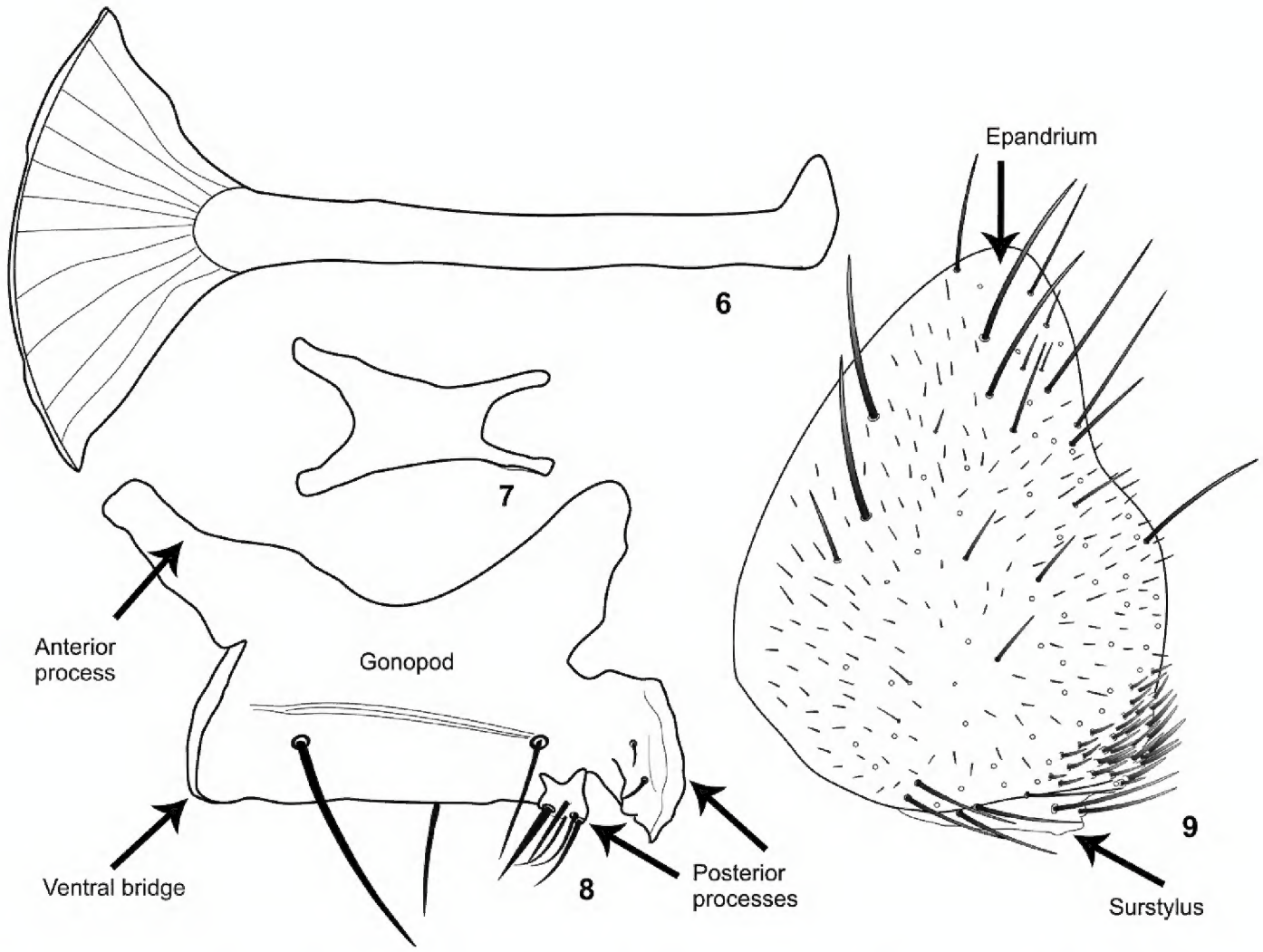
Figures 2–5. Digital photographs of *Aulacigaster zurqui* sp. nov., paratype female: (2) habitus, lateral view; (3) habitus, dorsal view; (4) head, forntal view; (5) head, lateral view. Specimen is 2.6 mm long. Not all to the same scale.

tubercle, with a shiny spot extended from ocellus to eye margin; ocellar tubercle dull microtomentose; frons uniformly microtomentose, silver under certain angles; antenna pale yellow to yellowish, infuscate on dorsal margin; face dark-brown to black, yellowish ventrally; gena mostly yellowish; facial band absent, face entirely glossy; palpus white. Pleural region uniformly black; scutum mostly completely microtomentose; scutellum dull microtomentose; postpronotum yellowish to pale brown, scarcely microtomentose, subshiny; anepisternum mostly dull; katepisternum subshiny to dull; halter mostly white; wings hyaline. Fore coxa brown to black, fore femur brown, apical 1/4 yellow, fore tibia yellowish, fore tarsus yellowish; mid coxa brown to black, mid femur brown or brown to black, apical 1/4 yellow, mid tibia yellowish, mid tarsus mostly yellowish; hind coxa brown, hind femur brown or brown to black, apical 1/4 yellow, hind tibia yellowish, hind tarsus yellowish. Abdomen completely dark brown to black; female abdomen uniformly microtomentose medially.

Morphology. Body robust, scutal ratio 1.1–1.2. Head: Head higher than long (head ratio 0.7–0.8); 1st flagellomere triangular; face convex, at level of pseudovibrissal seta approximately 2/3 times the width of the longest axis of 1st flagellomere; medial vertical seta 1/2–3/4 length of lateral vertical seta; 3 strong peristomal seta present, following pseudovibrissal seta, posteriormost seta the longest.

Thorax. Acrostichal setae in 2 rows; scutellum strongly raised (angle with scutum less than 135°), approximately triangular, apex rounded, disk of scutellum convex; basal scutellar seta a little less than 1/2 length of posterior seta; wings with one row of stronger setae on Coastal vein.

Male abdomen and terminalia: Surstylus inconspicuous in lateral view in unprepared specimens, folded beneath the epandrium and appearing as a strongly setose postero-ventral region. After preparation, an approximately triangular sheath can be observed in lateral view, bearing 2 long setae, one pre-apical



Figures 6–9. Digital photographs of *Aulacigaster zurqui* sp. nov., holotype male, genitalia: (6) aejaculatory apodeme, dorsal view; (7) subepandrial sclerite, dorsal view; (8) gonopod, lateral view; (9) epandrium and surstylus, lateral view. All to the same scale.

COSTA RICA. Prov. San José. Moravia. Zurquí de Moravia, Tower path. 1600m. 21-28 JUN 2013. Proyecto ZADBI. Malaise trap #1, 0m., ZADBI-890. -84:00:57 10:02:58. #107111
INB0004447458
INBIOCRI COSTA RICA
HOLOTYPE ♂
Aulacigaster zurqui
Rung 2017 MNCR

Figure 10. *Aulacigaster zurqui* sp. nov.: digital photographs of the labels pinned with the male holotype.

and one apical; subepandrial sclerite with 2 lateral arms on each end, nearly parallel, well sclerotized; anterior dorsal process of gonopod subequal in size to anterior dorsal process; gonopod subrectangular, wider than high in profile, with posteriormost ventral process pointed, at base as wide as base of anterior dorsal process; anteriormost ventral process bearing 5 strong, strong setae; cerci lost during preparation.

Measurements: Body length 2.5 (male)–2.6 (female) mm. Wing (female only) length 3 mm, wing width 1.1 mm.

Etymology. The specific epithet, *zurqui*, is the cloud forest where the species was collected. The name is a noun in apposition.

Distribution. Neotropical: COSTA RICA (San José and Cartago).

Ecology. Nothing is known about the habits and biology of this new species.

FINAL REMARKS

Including this contribution, 14 species of *Aulacigaster* are known from Costa Rica. The new species, *A. zurqui*, belongs to the *plesiomorphica* species-group according to a cladistic analysis and is united with the other species of that group by one homoplasious synapomorphy: the presence of a process on the posterior portion of the gonopod bearing long, strong setae.

ACKNOWLEDGEMENTS

This research was partly funded by US National Science Foundation grant DEB 1145890 to B. Brown and A. Borkent.

LITERATURE CITED

Borkent A, Brown BV (2015) How to inventory tropical flies (Diptera) – one of the megadiverse orders of insects. Zootaxa 3949: 301–322. https://doi.org/10.11646/zootaxa.3949.3.1

Cole EJ, Streams FA (1970) Insects emerging from brown slime fluxes in southern New England. The Canadian Entomologist 102: 321–333. https://doi.org/10.4039/Ent102321-3

Davis EJ, Zack RS (1978) New host records and notes on the dipterous family Aulacigastridae. The Pan-Pacific Entomologist 54: 129–130.

Cumming JMB, Sinclair J, Wood DM (1995) Homology and phylogenetic implications of male genitalia in Diptera- Eremoneura. Entomologica Scandinavica 26: 121–149. https://doi.org/10.1163/187631295X00143

Farris JS (1969) Successive approximations approach to character weighting. Systematic Zoology 18: 374–385. https://doi.org/10.2307/2412182

Ferrar P (1987) A guide to the breeding habits and immature stages of Diptera Cyclorrhapha. Entomonograph 8: 1–478; (2): 479–907.

Hilger S, Kassebeer CF (2000) A New Species of *Aulacigaster* Macquart 1835 (Diptera, Aulacigastridae) from Réunion. Dipteron 3: 167–172.

Mathis WN, Freidberg A (1994) A review of North American *Aulacigaster* Macquart (Diptera: Aulacigastridae). Proceedings of the Entomological Society of Washington 96: 583–598.

McAlpine JF (1981) Morphology and Terminology – Adults. In: McAlpine JF (Ed.) Manual of Nearctic Diptera. Research Branch, Agriculture Canada, Ottawa, Monograph 32, vol. 1, 9–63.

Papp L (2008) Description of the immature stages and the adult female of *Aulacigaster africana*, the first known for the Afrotropical Aulacigastridae (Diptera: Schizophora). African Invertebrates 49: 227–232. https://doi.org/10.5733/afin.049.0211

Robinson I (1953) The postembryonic stages in the life cycle of *Aulacigaster leucopeza* (Meigen) (Diptera, Cyclorrhapha: Aulacigasteridae). Proceedings of the Royal Entomological Society of London (A) 28: 77–84. https://doi.org/10.1111/j.1365-3032.1953.tb00648.x

Rung A, Mathis WN, Papp L (2005) *Curiosimusca*, gen. nov., and three new species in the family Aulacigastridae from the Oriental Region (Diptera: Opomyzoidea). Zootaxa 1009: 21–36. https://doi.org/10.11646/zootaxa.1009.1.3

Rung A, Mathis WN (2011) A revision of the genus *Aulacigaster* Macquart (Diptera, Aulacigastridae). Smithsonian Contributions to Zoology 633: 1–132. https://doi.org/10.5479/si.00810282.633

Swofford DL (2002) PAUP*. Phylogenetic analysis using parsimony (* and other methods). Version 4.

Submitted: 3 April 2017
Received in revised form: 6 June 2017
Accepted: 18 June 2017
Editorial responsibility: Ralph Holzenthal